

**State of the Art (SOTA)
Manual
for Chemical and Pharmaceutical Processing
and Manufacturing Industries**

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State of New Jersey
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State of the Art (SOTA)
Manual for Chemical and Pharmaceutical Processing
and Manufacturing Industries
Section 3.5

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3.5.ii ABBREVIATIONS

ACT	Alternative Control Techniques
BACT	Best Available Control Technology
BAQEv	NJDEP Bureau of Air Quality Evaluation
CARB	California Air Resources Board
HAP	Hazardous Air Pollutants
LAER	Lowest Achievable Emission Rate
MACT	Maximum Achievable Control Technology
NJDEP	New Jersey Department of Environmental Protection
PPM	Parts Per Million
RACT	Reasonably Achievable Control Technology
SOTA	State of the Art
US EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

3.5 SOTA MANUAL FOR CHEMICAL AND PHARMACEUTICAL PROCESSING AND MANUFACTURING INDUSTRIES

3.5.1 Scope

These SOTA Performance Levels apply to the following sources:

- A. Continuous chemical operations sources, including but not limited to: reactors, filters, dryers, distillation columns, extractors, crystallizers and mixing/blending/ holding tanks.
- B. Batch chemical/pharmaceutical operations sources, including but not limited to: reactors, filters, dryers, distillation columns, extractors, crystallizers, and mixing/blending/holding tanks.

Storage tanks; sterilizers; wastewater treatment facilities; bakeries; paint manufacturing; ink and adhesive manufacturing; graphic arts and surface coating operations are addressed in other sections of this SOTA Manual.

3.5.2 SOTA Performance Levels

This manual defines SOTA Performance Levels for chemical handling/pharmaceutical manufacturing operations, emitting the following pollutants:

- Regulated volatile organic compounds (VOCs)¹
- Acid/base gases
- Particulate matter (Particles including HAP and heavy metal)²

The reader is advised that in certain cases more stringent control levels may be required by regulation (e.g. N.J.A.C. 7:27-16). In that case, the more stringent requirements shall apply.

3.5.2.1 Post Process Control Options

Capture Efficiency

The state of the art for capture efficiency is 100%. This means that 100 percent of the pollutants emitted from the source shall be ducted to the control device as prescribed by EPA Test Method 204. Existing sources that cannot achieve the 100 percent capture

¹Volatile organic compounds as defined in N.J.A.C. Subchapter 16 including Hazardous Air Pollutants as defined in Federal Regulations 40 CFR 63.2.

²Defined in Subchapter 6 as “any material, except uncombined water, which exists as liquid particles or solid particles at standard conditions.”

efficiency will be handled on a case-by-case basis. The 100% capture requirement does not apply to material transfer components subject to leak detection and repair requirements and operation events such as manual charging and product intermediate sampling.

Control Efficiency

For a single control device the control efficiency shall be measured from the inlet to the outlet of the device. For multiple device control systems, the control efficiency shall be measured from the inlet to the control train to the outlet of the control train. The control efficiency must meet the most stringent requirement for any single control device in the control train. For batch operations, the control efficiency may be determined based on the batch cycle emission rate as defined in NJAC 7:27-16-1.

Total Volatile Organic Compounds (including HAPs)

Table 1
SOTA Performance Levels for Organic Compounds and Organic HAPs³

Air Pollution Control Technology	Total VOCs	
	Control Efficiency	Basis
Destruction Devices	Minimum destruction efficiency of 98 percent by weight or 20 ppmv ⁴ dry at 3% O ₂ at the outlet ⁵ (one hour average)	MACT, NSPS Standards, US EPA Surveys and ACT
Recovery Devices	Minimum removal efficiency of 95 percent by weight or 20 ppmv ⁴ , unadjusted, at the outlet (one hour average)	NJDEP Permit Review, RACT/BACT/LAER Clearinghouse, CARB BACT Clearinghouse, US EPA CTG's EPA Documents

³NJAC 7:27.16 may require control above the efficiencies listed here. In those cases the most stringent requirement shall be met for control.

⁴Expressed as methane, C₁, excluding methane, and determined as the average through batch cycle time for non-continuous operations.

⁵For O₂ content greater than 12%, the outlet concentration must be less than 10 ppmv (unadjusted).

- Destruction Devices

SOTA for oxidation is considered to be a minimum of 98 percent destruction efficiency of total VOCs (including organic HAPs). Destruction devices include thermal, catalytic, and flameless thermal oxidizers. Typical operating parameters for thermal oxidizers may include a residence time greater than 0.5 seconds, a temperature greater than 1,500°F, and a carbon monoxide (CO) concentration below 100 parts per million volume (ppmv) corrected to 7% oxygen at the outlet. In addition, a particle prefilter is typically required on catalytic oxidizer units.

- Recovery Devices

Recovery devices include condensation, adsorption, and absorption systems. SOTA for these control technologies is considered to be a minimum of 95 percent control efficiency for total VOCs. Typical applications of carbon adsorption systems include two units in series or a breakthrough detector. Mist eliminators are typically required following absorption units.

- Biofiltration

A number of biofiltration applications have been permitted by NJDEP, for VOC removal and odor control. However, there is not a sufficient amount of data available at this time to justify industry-wide SOTA performance levels for biofilters. Future reviews of this SOTA section may reveal a significant amount of data which may justify a reevaluation for this industry source category. At this point in time, NJDEP will consider biofiltration as a SOTA technology on a case-by-case basis.

- Emerging Control Technologies

Other emerging control technologies that have been reported but are not widely used at this time are ultraviolet oxidation, ozonation, corona destruction, plasma technology, and hybrid technologies. An adequate amount of data on the efficiencies of these processes does not exist. Therefore the SOTA Performance Levels for these emerging technologies will be handled on a case-by-case basis.

Total Particulate Matter (including HAP)

SOTA for all control technologies is considered to be a maximum outlet concentration of 0.02 grains per dry standard cubic foot (gr/dscf). Examples of particulate control technologies include: baghouses, fabric filters (e.g. HEPA, cartridge), electrostatic precipitators, and high energy scrubbers (e.g. venturi).

Table 2
SOTA for Particulates

Air Pollution Control Technology	Particles	
	Emission Limit	Basis
Fabric Filters Electrostatic Precipitators Absorption Inertial Separation ⁶	Maximum outlet concentration of 0.02 grains per dry standard cubic foot (one hour average)	NJDEP Permit Review, RACT/BACT/LAER Clearinghouse

Inorganic Acid/Base Gases

- Absorption

Acid gas emissions are best controlled by absorption/scrubbing systems. At or above moderate levels of concentrations, this technology has a proven record of achieving greater than or equal to 99 percent⁷ removal efficiency.

Table 3
SOTA for Inorganic Acids and Bases

Air Pollution Control Technology	Acids/Bases	
	Control Efficiency	Basis
Absorption	Wet scrubbing - minimum 99 percent control efficiency or a maximum concentration of 10 ppmv at discharge (one hour average)	NJDEP Permit Review, MACT Standards

⁶Inertial Separators do not typically achieve the specified emission limit without an additional particulate control.

⁷Review of N.J.A.C. Operating Permit Applications.

3.5.3 Technical Basis

Volatile Organic Compounds (including HAPs)

- Destruction Devices

A review of the Survey of Control of Technologies for Low Concentration Organic Vapor Gas Streams, EPA-450/R-95-003, identifies three applications of thermal oxidation and one application of catalytic oxidation which achieve 98% efficiency. The Control of Volatile Organic Compound Emissions from Batch Process, EPA-453/R-93-017, and the Control of Volatile Organic Compound Emissions from Batch Process - Alternative Control Techniques, EPA-453/R-94-020, both identify thermal and catalytic oxidation as being capable of achieving 98% efficiency. The *National Emission Standard for Hazardous Air Pollutants (NESHAP) for Epoxy Resins Production and Non-Nylon Polyamides Production*, 40 CFR Part 63 Subpart W, requires a 98% control efficiency for process vents on basic liquid epoxy resin (BLR) sources. The *NESHAP for the Synthetic Organic Chemical Manufacturing Industry (SOCMI) for Process Vents, Storage Vessels, Transfer Operations, and Wastewater*, 40 CFR Part 63 Subpart G, as well as the *New Source Performance Standards (NSPS) for SOCMI Air Oxidation Processes*, 40 CFR Part 60 Subpart III, and the *NSPS for SOCMI Reactor Processes*, 40 CFR Part 60 Subpart RRR, all require a control efficiency of 98% or an outlet concentration of 20 ppmv on a dry basis at 3% O₂.

- Recovery Devices

A review of permits issued by New Jersey Department of Environmental Protection identifies ten applications of condensation which achieves a minimum of 95% efficiency.

A review of permits issued by New Jersey Department of Environmental Protection identifies four applications of absorption which achieve a minimum of 95% efficiency. The Survey of Control Technologies for Low Concentration Organic Vapor Gas Streams identifies one facility using absorption to achieve a minimum of 95% control efficiency. The EPA RACT/BACT/LAER Clearinghouse identifies two sources using absorption, at a control efficiency of 95%, to meet the requirements of BACT.

A review of permits issued by New Jersey Department of Environmental Protection identifies one application of adsorption which achieves a minimum of 95% efficiency. The Survey of Control Technologies for Low Concentration Organic Vapor Gas Streams identifies three facilities using adsorption to achieve a minimum of 95% control efficiency. The California Air Resources Board (CARB) BACT Clearinghouse identifies one source using adsorption, at a control efficiency of 95%, to meet the requirements of BACT.

Particulate Matter

A review of permits issued by New Jersey Department of Environmental Protection identifies one source and a review of the EPA RACT/BACT/LAER Clearinghouse identifies six sources which use absorption to achieve an efficiency of 99%. The EPA Clearinghouse also identifies three source which use fabric filters to achieve a minimum efficiency of 99%.

Inorganic Acid/Base Gases

A review of permits issued by New Jersey Department of Environmental Protection identifies one source that is able to achieve an efficiency of 99% through the use of absorption. The *NESHAP for the Synthetic Organic Chemical Manufacturing Industry (SOCMI) for Process Vents, Storage Vessels, Transfer Operations, and Wastewater*, 40 CFR Part 63 Subpart G requires a 99% efficiency.

3.5.4 Recommended Review Schedule

The recommended review schedule is two years after the effective date of the manual. This review schedule was chosen for several reasons:

- A.) The two year time period allows for an initial implementation period, in which time sufficient experience can be gathered regarding the use of this manual.
- B.) The large number of sources covered by this section of the manual.
- C.) Anticipated MACT Standards to be promulgated in 1997 and 1998, affecting these sources.

3.5.5 References

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2. Control of Volatile Organic Compound Emissions Air Oxidation Processes in Synthetic Organic Chemical Manufacturing Industry, Guideline Series, EPA-450/3-84-015, December 1984.
3. Control of Volatile Organic Compound Emissions from Batch Process - Alternative Control Techniques, EPA-453/R-94-020, February 1994.
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5. Davis, W.T., Buonicor, A.J., Air Pollution Manual, Air and Waste Management Association, 1992.
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7. Moretti, et. al., VOC Control: Current Practices and Future Trends, Chemical Engineering Progress, 89/7, p. 20-26, July 1993.
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9. Vatauvuk. W.M., Estimating Costs of Air Pollution, Lewis Publishers, 1990.